NEW YORK STATE | Department of Environmental Conservation

Croton River Hydrilla Control Project

2021 ANNUAL UPDATE

Kathy Hochul, Governor | Basil Seggos, Commissioner

New York State Department of Environmental Conservation
Division of Lands and Forests
Bureau of Invasive Species and Ecosystem Health

CROTON RIVER HYDRILLA CONTROL PROJECT
2021 ANNUAL UPDATE

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List of Abbreviations

CFS	Cubic Feet per Second (1 cfs = 1.858 million gallons per day)
DEC	New York State Department of Environmental Conservation
ISCS	DEC's Invasive Species Coordination Section (within the Division of Lands and Forests)
NYCDEP	New York City Department of Environmental Protection
PPB	Parts per Billion (1 ppb = 1 microgram per liter)
PRISM	Partnership for Regional Invasive Species Management
SAV	Submerged Aquatic Vegetation
USGS	United States Geological Survey
WISP	Watercraft Inspection Steward Program

Year in Review

Through the ongoing work of the New York State Department of Environmental Conservation (DEC) and its partners, 2021 marked the fifth year of the Croton River Hydrilla Control Project treatment. *Hydrilla verticillata*, an aquatic plant from Asia, is one of the most difficult aquatic invasive species to control and eradicate in the United States. Infestations can have negative impacts on recreation, tourism, and aquatic ecosystems. If the infestation of hydrilla in the Croton River is allowed to reach the Hudson River, the tide could potentially spread it along 153 miles of estuary to each connecting tributary and beyond. This annual update outlines the accomplishments of the treatment project in 2021, as well as plans for a proposed 6th year of treatment in 2022.

Figure 1: Healthy hydrilla in the Croton River in 2016 (top), and damaged, bleached hydrilla mid--treatment season in 2021 (bottom)

2021 Highlights

- DEC's contractor (SŌLitude Lake Management) applied herbicide between June 7 and September 15. There were a total of 70 treatment days, which fell short of the 90-day target treatment goal. This was due to high flows in the Croton River following Hurricane Ida.
- In 2021, DEC and its partners conducted: multiple snorkeling surveys, a point-intercept aquatic plant survey, wading/visual surveys, and tuber/turion surveys on the Croton River.
- DEC found a at total of 10 hydrilla plants during several surveys throughout the entire Croton River in 2021.
- Hydrilla that was found by DEC staff and contractors showed significant signs of herbicide injury, reduced size, and impacts to plant health (see Figure 1).
- Following the 2021 treatment season, DEC staff and contractors surveyed 446 points on the Croton River for submerged aquatic vegetation (SAV). They found rooted hydrilla plants at 0.004% of points in 2021 (while 42.6% of points had hydrilla in 2016, 15.25% in 2017, 6.56% in 2018, 0% in 2019, and 1.7% in 2020). For an accurate reporting of rooted hydrilla from 2017–2021, please see Table 2.
- DEC's contractors sampled eight sites for hydrilla tubers (245 cores total) following treatment and found no tubers or turions during the 2021, 2020, and 2019 surveys. This suggests herbicide treatment has weakened plants enough to prevent reproductive structures from forming and overwintering.
- Drinking water samples collected twice per week revealed fluridone levels ≤0.86 ppb throughout the entire treatment season (well within the 0.0 ppb–4.0 ppb concentration range designated for this project).
- DEC staff and contractors sampled 1,469 points for SAV at 29 high-priority sites along the lower Hudson River Estuary and no hydrilla plants were present.

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Introduction

About Hydrilla

Hydrilla, or "water thyme" (*Hydrilla verticillata*), is a vascular aquatic plant from Asia that is one of the most difficult invasive species to control and eradicate in the United States. Infestations can have negative impacts on recreation, tourism, and aquatic ecosystems. Hydrilla has been a popular aquarium plant for many years; however, it is now listed by the federal government as a "noxious weed." New York State law prohibits possession of hydrilla with the intent to sell, import, purchase, transport, introduce, or propagate it (6 NYCRR Part 575 Prohibited and Regulated Invasive Species).

In New York State, hydrilla is a perennial plant that emerges in late spring to early summer and grows along the bottom of wetlands, rivers, streams, lakes, and ponds. Its monoecious form (containing both male and female organs on the same plant) is capable of overwintering in New York State. Hydrilla produces dense mats of vegetation that extend from the river bottom to the surface of the water and displace native plants that provide food and shelter for native aquatic wildlife.

To propagate, hydrilla can produce seeds, green buds called turions, and tubers. Turions are overwintering buds found where leaves attach to stems. Tubers are potato-like reproductive structures that form on the roots of the plant each fall and allow hydrilla to store energy and regenerate the following spring. New populations of hydrilla can sprout from seeds, turions, and tubers, as well as from plant fragments that easily break off the plant. These extremely effective dispersal methods make manual control of hydrilla nearly impossible.

Figure 2: *Hydrilla verticillata*

The Croton River Hydrilla Control Project

DEC has been monitoring the hydrilla infestation since its discovery in the Croton River in October 2013. Control and eradication methods in the Croton River are based on an adaptive management strategy outlined in the *Croton River Hydrilla Control Project Five-Year Management Plan* (see the Five-Year Plan at: **https://www.dec.ny.gov/animals/106386.html**). This annual update outlines the accomplishments of the treatment project in 2021 (year five).

2021 Permitting

The DEC Invasive Species Coordination Section (ISCS) obtained the following permits to operate during the 2021 treatment season:

- Article 15 Aquatic Pesticide Permit AV-3-21-316, issued 4/30/2021, modified 6/30/21 (Expiration: 03/15/2022)
- Article 24 Freshwater Wetlands Permit, issued 6/29/17 (Expiration: 12/31/2021)
- Special Local Needs Permit for Sonar Genesis® from the New York State Department of Health (DOH), issued 04/15/2017, updated 12/14/2018 (Expiration: 12/31/2021)
- SPDES General Permit GP-0-16-005, Acknowledgement of Notice of Intent (NOI), issued 5/19/2017 (Expiration: 10/31/2021)
- Westchester County Land Use Permit, issued 5/9/2018 (Expiration: 12/31/2021)
- NYCDEP Temporary Land Use Permit, issued 6/29/2017 (Expiration: 6/28/2022)
- 6 NYCRR Part 175 ECL 11-0515 (1) 6 NYCRR Part 189 License to Possess or Collect: Scientific # 2765, issued 9/11/20 (Expiration: 9/10/2021)
- 6 NYCRR Part 575 Possession Permit, issued 11/15/18 (Expiration: 11/15/2023)

2021 Field Season Activities

Herbicide Treatments

The 2021 herbicide treatment involved injecting the aquatic herbicide fluridone (trade name: Sonar Genesis® [Environmental Protection Agency Reg. No. 67690-54]) into the Croton River at a concentration of 2.0–4.0 ppb for 70 days. Information about the efficacy of low-dose fluridone treatments of infested flowing waters can be found in the *Croton River Hydrilla Control Project Five-Year Management Plan*. Links to the plan and the NYS Special Local Needs Label for Sonar Genesis® can be found in Appendix A. Sonar Genesis® is a liquid herbicide (active ingredient: fluridone) that SŌLitude applied to the river using subsurface injection from remote-controlled (via cell phone) injection systems placed at two locations on the Croton River.

The first injection site was located just below the New Croton Dam and the second injection site was located approximately 1.1 miles downstream, near the concrete dam at Black Rock Park. Injection locations were selected to maximize treatment coverage and ensure product mixing (that the herbicide mixed with the water). Staff from SŌLitude and SePRO Corporation installed, calibrated, and maintained the units. A licensed pesticide applicator from SŌLitude filled and maintained the injection unit tanks.

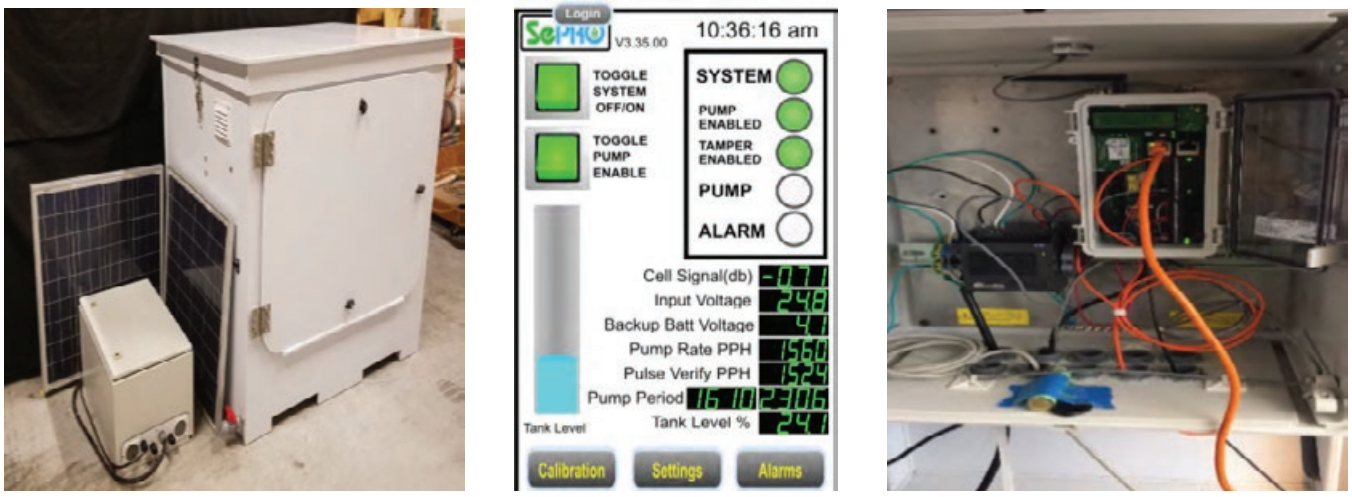

Figure 3: A fluridone injection unit (left), unit control dashboard (center), and cellular control device (right); credit: SePRO

Licensed applicators from SŌLitude determined the actual dosage and duration of the application daily by flow rates in the river, using discharge measurements from the U.S. Geological Survey (USGS) Hydrologic Station 01375000 (located just below the New Croton Dam), as well as the observed efficacy and label requirements of Sonar Genesis®. Pump rates were calculated daily and controlled by accessing a dashboard using a cellular device or laptop computer. Rates were adjusted periodically in response to flow, technical issues, FasT-EST monitoring results, or observed plant response, with the goal of maintaining a target dose of 2.0–4.0 ppb, and a permitted dose of 1.0–5.0 ppb throughout the entire length of the Croton River. SŌLitude licensed applicators and SePRO staff conducted unit operations.

Prior to the beginning of treatment, DEC and SŌLitude installed permanent, weatherproof, bilingual signs with information about the fluridone treatment, in compliance with the Article 15 Aquatic Pesticide Permit, at the following public access locations:

- Croton Gorge Park – 18 “No Irrigation” posters
- Black Rock Park – 14 “No Irrigation” posters
- Silver Lake Beach – 6 “No Irrigation” posters
- Croton Gorge Unique Area – 3 “No Irrigation” posters
- Public Park at Paradise Island – 4 “No Irrigation” posters
- Echo Boat Launch – 1 “No Irrigation” poster

The treatment season began on June 7 and ended on September 15. The herbicide Sonar Genesis® was applied for 70.5 days, which fell short of the 90-day goal for the project, due to high flows following Hurricane Ida. A total of 546.5 gallons of Sonar Genesis® were applied in 2021 (SŌLitude, 2021). The New Croton Dam and Black Rock Park injectors maintained a rate of 2.5 and 1.0 ppb respectively.

River Conditions

Discharge

DEC’s ISCS developed a Pesticide Discharge Management Plan as an operational protocol as part of the State Pollutant Discharge Elimination System (SPDES) permit. In 2021, the Pesticide Discharge Management Plan for this project targeted treatment in waters flowing at a rate less than 500 cubic feet per second (cfs) in an effort to ensure fluridone concentrations would remain within the target range of 2.0–4.0 ppb. Discharge (the volume of water in the Croton River) results from a combination of controlled bottom releases (using doors at the base of the New Croton Dam) and water spilling over the top of the dam. Discharge is measured at the USGS Hydrologic Station 01375000 (located along the Croton River, 1,000 feet downstream of the New Croton Dam). In 2021, historically high flows and equipment damage from Hurricane IDA ended the treatment season early. In total, 31 treatment shutdown days occurred during the 2021 treatment season due to high flows or equipment issues. Comparatively, there was one shutdown day during the 2020 treatment season, 8.5 shutdown days during the 2019 treatment season, 60 during the 2018 treatment season, and four during the 2017 treatment season. Figure 4 displays the changes in flow during the treatment season.

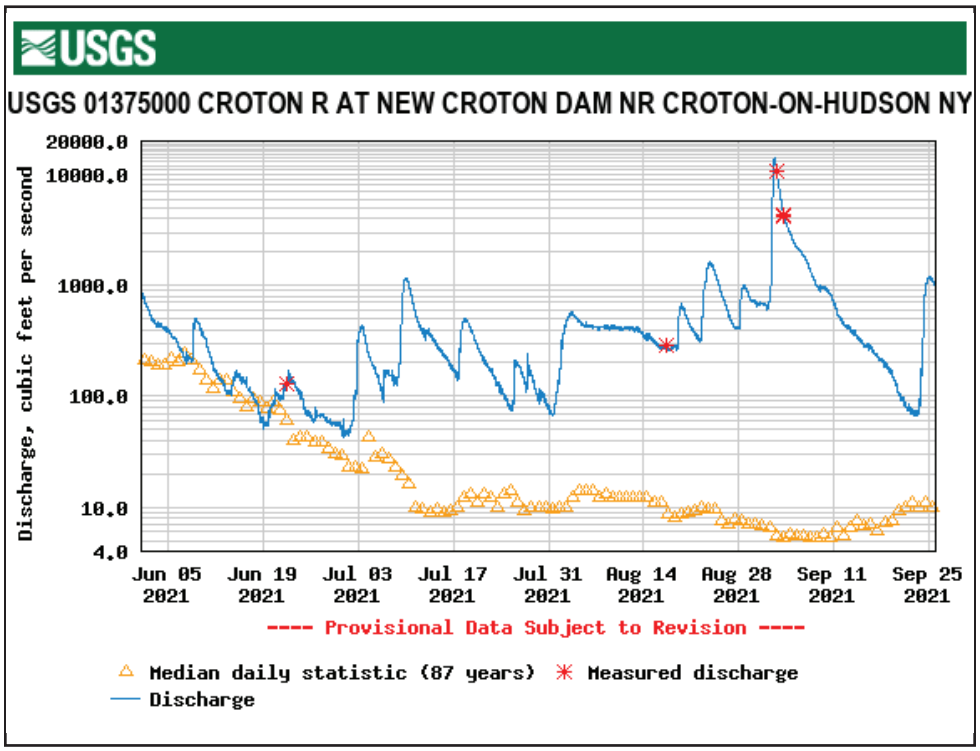

Figure 4: Croton River Discharge – June–September 2021. USGS (“R” = River, “NR” = near)

Temperature

Water temperature in the Croton River results from a mix of surface water spill received from the New Croton Reservoir and controlled release from below the thermocline. Water spilling from the surface of the reservoir down into the river can reach 80°F during the summer months. NYCDEP maintains a release schedule based on Title 6 of New York Code, Rules and Regulations Part 672 6 CRR NY 672 3.3 – Operation of Reservoirs (Section e: New Croton). Because controlled release valves are located within the reservoir below the thermocline, release water consistently measures 48°F throughout the season. Hydrilla tubers have been found to germinate at temperatures just above 50°F; however, temperatures between 60-80°F are considered ideal for hydrilla germination and growth. A thermograph installed by DEC Region 3 Fisheries revealed the Croton River measured between 60-85°F during the 2021 treatment season.

Water Quality Sampling

SŌLitude and the Village of Croton-on-Hudson Water Department collected drinking water samples throughout the 2021 field season. Drinking water (from wells) and finished water (water that is released to the public from the Village of Croton-on-Hudson's distribution system) were collected and analyzed. Samples were collected from three village wells (DW-1, DW-3, and DW-4), one faucet (FW-1), and two distribution sites (Upper North Highland Pump House [UNH-1] and the Village of Croton-on Hudson Municipal Building [MB-1]). All water samples were analyzed for fluridone concentration by Phoenix Labs in Manchester, Connecticut, to a 0.29 ppb detection limit. Twice a week, one sample was collected from each sampling location. Every other week, two samples (A and B) were taken from each sampling location to test for variation among samples.

SŌLitude and the Village of Croton-on-Hudson Water Department conducted drinking water sampling twice per week throughout the treatment season that began on June 7. The highest fluridone concentration during the 2021 treatment season was 0.86 ppb (reached on August 17), well under the 4.0 ppb limit set by this project. Figure 5 shows fluridone concentrations within drinking water wells. Figure 6 shows the highest fluridone concentration reached during each season of the herbicide treatment (2017-2021). Following treatment, sampling was conducted twice per week until two consecutive samples with readings of "non-detect" were found at all water sampling locations. Phoenix Lab reports containing sampling results from the finished water and drinking water were posted to the Croton River Hydrilla Project's Water Sample Analysis Results Page on DEC's website (**http://www.dec.ny.gov/animals/110624.html**).

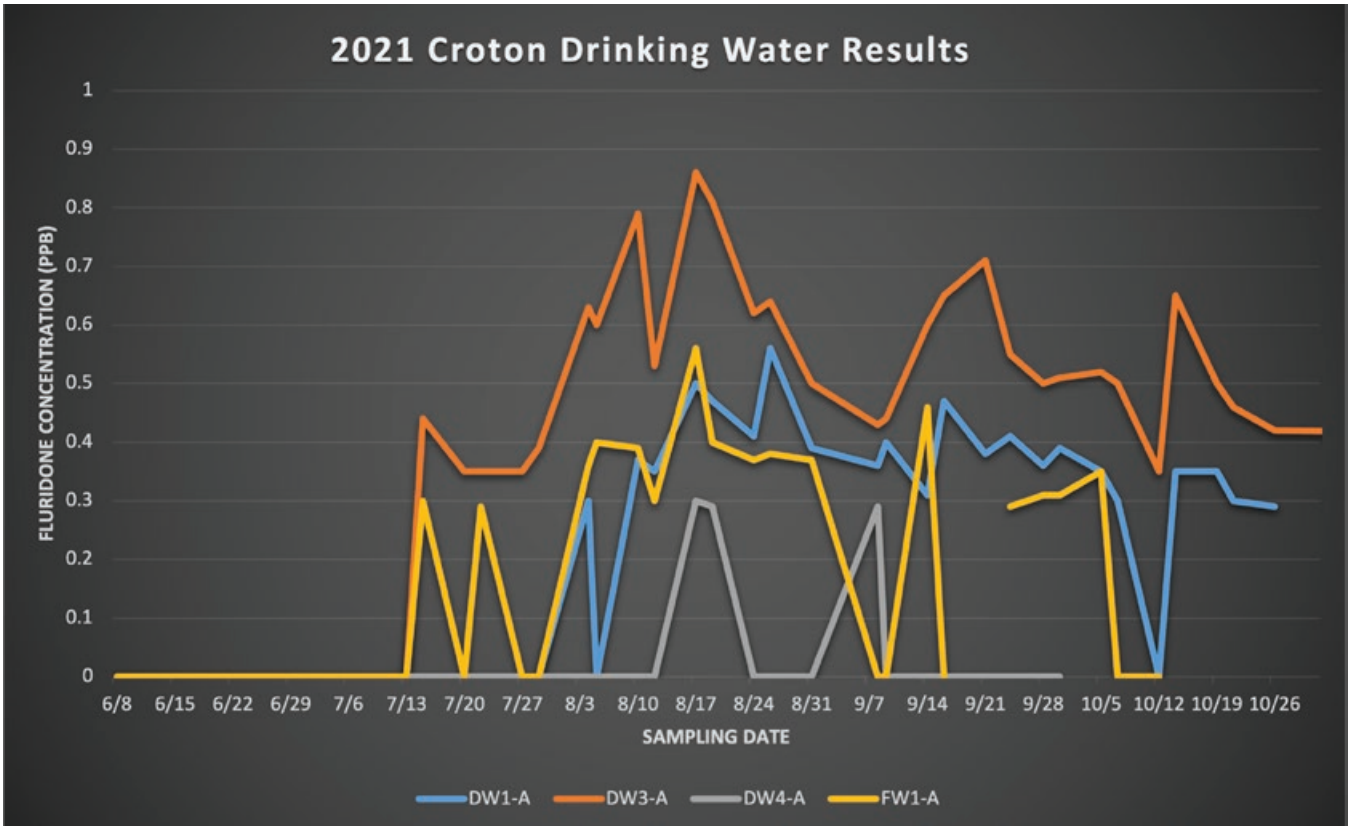

Figure 5: 2021 Village of Croton Well Results

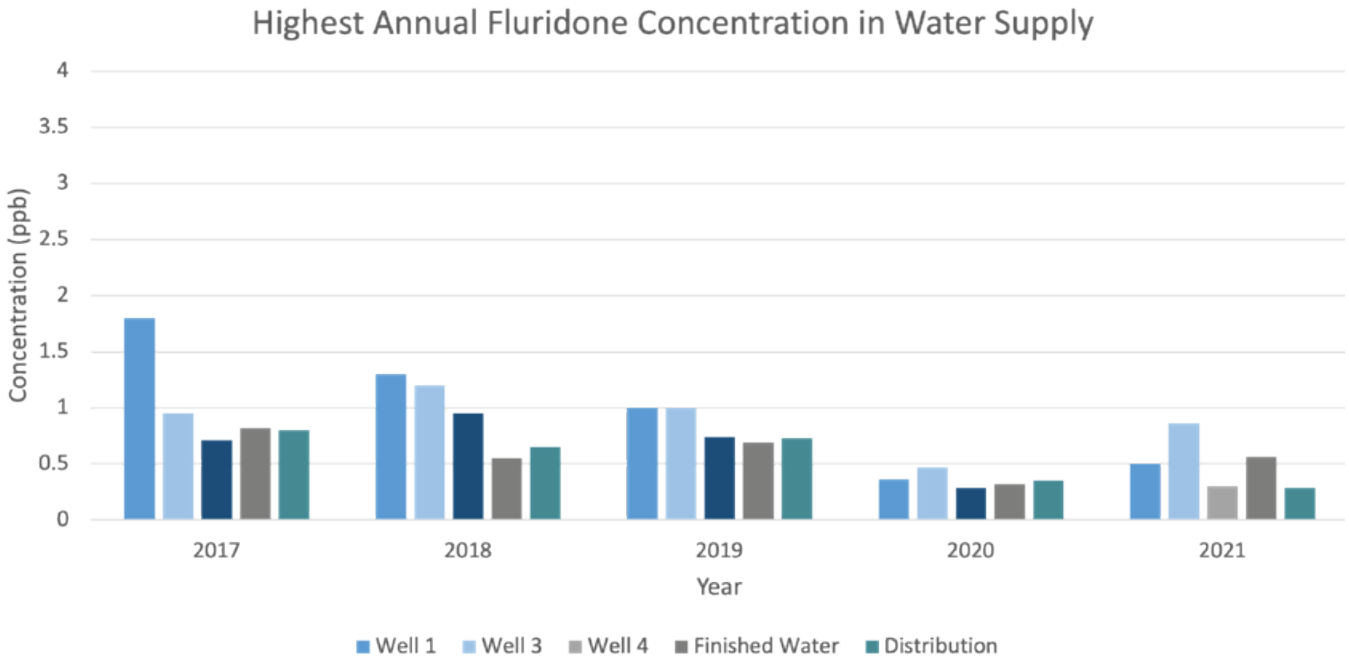

Figure 6: 2021 Village Distribution & Finished Water Results

Additionally, SŌLitude collected river water samples weekly at five sites along the Croton River (CR-1, CR-1.5, CR-2, CR-3, and CR-4) that Phoenix Labs analyzed for fluridone to a 0.29 ppb detection limit. River sampling concluded for the season on September 21, following the end of treatment, with all river site samples reporting non-detect for fluridone. Drinking water sampling ended for the season on December 30, 2021, when all wells were non-detect for fluridone in two consecutive samples. River water sample results were reported to DEC Region 3 Department of Materials Management as per the Article 15 Aquatic Pesticide Permit requirements.

Submerged Aquatic Vegetation Survey Results

Visual/Wading Surveys

DEC's ISCS typically conducts visual/wading surveys at three, five, and eight weeks into each treatment season. The purpose of the wading surveys is to determine when germination has begun and to assess the physical condition of treated plants as the treatment season progresses. Side-by-side comparisons to untreated plants from NYCDEP's New Croton Reservoir have historically been used to provide important visual indicators about how the treatment is going.

Untreated plants for comparison were unavailable this season, as NYCDEP began full-scale fluridone treatment for hydrilla within the New Croton Reservoir.

Figure 7. Invasive hydrilla (left) and native Elodea (right) collected on the same day in the Croton River. Hydrilla shows more bleaching from the treatment.

A single wading survey was completed at CR-4 three weeks after treatment began and no hydrilla was found. Water clarity is essential to locate hydrilla plants during wading surveys. Following the CR-4 survey, NYCDEP undertook operational changes within their East-of-Hudson reservoir system, resulting in an increase in turbidity within the Croton River. Turbidity remained too high to conduct any further wading surveys in 2021, and the project replaced the remaining visual surveys with an increase in snorkel/SCUBA survey efforts for 2021 in order to deal with poor visibility in the Croton River.

Figure 8. Croton River treated hydrilla plant showing bleaching and loss of leaves collected 7 weeks after treatment began.

Snorkel Surveys

A snorkel survey was conducted on June 7 (Day 1 of treatment) at CR-2 by DEC ISCS to verify tuber germination. A single hydrilla sprout with tuber was found. A snorkel survey was conducted seven weeks after treatment by DEC ISCS and SePRO at CR-2 to assess plant condition. In total, seven hydrilla plants were found, all of which showed growth in length, but no spread of horizontal shoots. All plants observed showed signs of herbicide injury, including stunted growth, loss of older leaves, and bleaching of plant tissues. A third snorkel survey was conducted 9 weeks after treatment by DEC ISCS and the Lower Hudson PRISM Aquatic Invasives Strike Force to assess plant condition and the treatment impact at CR-3. No hydrilla plants were found.

Fragment Surveys

A scientific collection license was obtained through NYSDEC's Special Licenses Unit in coordination with Region 3 Fisheries for net deployment near USGS Hydrologic Station 01375000 in order to capture and analyze fragments of hydrilla that were carried in surface water spill from the New Croton Reservoir. Fragment data are necessary to assess the risk of re-infestation from untreated sections of the New Croton Reservoir. NYCDEP began a full-scale fluridone treatment within the reservoir in 2021. Treated fragments carry less risk of re-establishing. The operational changes that increased spill from the reservoir resulted in flows being too high for fragment nets to be safely deployed in 2021. Fragment surveying will continue in 2022, if possible (based on environmental conditions).

Point-Intercept SAV Surveys

Following the 2021 treatment season, biologists with SŌLitude conducted point-intercept (Madsen, 1999) aquatic plant surveys at the same 446 sample points utilized in the 2016, 2017, 2018, 2019, and 2020 SAV surveys within the Croton River. For ease of assessment, the Croton River is broken into six sections for the SAV surveys:

- Section A: Black Rock Park;
- Section B: Silver Lake Beach;
- Section C: River Islands;
- Section D: Lower River;
- Section E: Lower Coves;
- Section F: Croton Bay Wetlands.

Survey site maps can be found in Appendix B. These surveys were conducted on October 4-5 and 11. The 2021 results were compared to post-treatment data from 2020. Originally, the *Croton River Hydrilla Five-Year Management Plan* called for the contractor to conduct pre- and post-treatment aquatic plant surveys. However, because the treatment is proposed for such an early seasonal start (May), when many aquatic plants are either unidentifiable or have not yet emerged, the fall survey from each year will serve as the pre-treatment survey for the following season.

SŌLitude biologists conducted two 10-meter weed-rake tosses at each GPS-referenced sample point. Samples from each rake toss were identified to species when possible and percent cover was estimated (SŌLitude, 2021). A mean abundance of hydrilla was calculated for each site by assigning one of five semi-quantitative densities:

- No Plants (empty rake),
- Trace (1 or 2 stems per weed rake),
- Sparse (3 to 10 stems),
- Medium (more than 10 stems), or
- Dense (entire weed rake full of stems).

2021 SAV Findings

During the 2021 SAV surveys, biologists with SŌLitude identified all visible aquatic plants (macrophytes) to species when possible and calculated percent abundance for each of the 446 sample points. Table 1 contains the list of macrophytes that were identified and their status. Eight different species were identified in 2021: six native species and two exotic invasive species.

SŌLitude biologists observed rooted hydrilla plants in trace abundance at two (0.004%) SAV sites following treatment in 2021. Table 2 displays the total number of points that contained hydrilla ("overall" column) and their semi-quantitative densities ("trace," "sparse," "medium," and "dense" columns) between 2016 and 2021.

Critical SAV Communities

Hydrilla threatens to displace SAV beds, particularly those with native wild celery (Vallisneria americana) in both the Hudson River and tidal portions of the Croton River (Sections C–F). Following storm events in 2011, wild celery populations in the Hudson River Estuary declined by more than 90 percent, with no appreciable recovery in 2013 and 2014 (Hamberg, 2016). Wild celery abundance within the Croton River has been documented since 2014 as part of this project. Following treatment in 2019, wild celery abundance had increased (compared to 2018) within Sections D–F. However, following the 2020 treatment season, wild celery abundance significantly declined in all sites sampled. The decline continued in 2021, with rooted wild celery being found within only one section of the Croton River, and only floating fragments being found within Croton Bay.

DEC is working with researchers from the University of Maryland Center for Environmental Sciences to determine genotypes and assess potential impacts of fluridone on different genotypes of wild celery growing in the lower Croton River. Wild celery plants were collected in 2017 (and GPS-referenced) for the purpose of genetic testing, propagation, and replanting throughout the treatment area in the future. Results of genetic testing revealed at least eight distinct genotypes—indicating very high genetic diversity at the mouth of the Croton River project site (personal communication, Katia Englehardt and Maile Neel, ND). Each genotype was subjected to seven different concentrations (0–6 ppb) of fluridone (and each combination of genotype × concentration was replicated 10 times in the lab). Leaf bleaching was observed at both 5 and 6 ppb. While plant stress was observed, none of the herbicide concentrations used in the treatment project appeared to be lethal in the lab setting. Results are preliminary and further study will advise on the timeline for future wild celery restoration efforts in the Croton River. Plants can be propagated in the lab and replanted in geo-referenced locations to restore a genetically diverse population of this important native species within the lower Croton River. Restoration efforts will be heavily dependent on the treatment timeline in the New Croton Reservoir, and DEC will remain in close communication with NYCDEP regarding this effort.

Table 1: 2021 Croton River Macrophytes		
Common Name	**Latin Name**	**Status**
Benthic filamentous algae	*various taxa*	–
Eurasian watermilfoil	*Myriophyllum spicatum*	aggressive, exotic, invasive
Hydrilla	*Hydrilla verticillata*	aggressive, exotic, invasive
Muskgrass	*Chara sp.*	native
Sago pondweed	*Stuckenia pectinata*	native
Watermoss	*Fontinalis Sp.*	native
Water stargrass	*Heteranthera dubia.*	native
Wild celery	*Vallisneria americana*	native

Table 2: Croton River Hydrilla Vegetative Biomass Reduction Summary 2016–2020					
Year	**Trace Points**	**Sparse Points**	**Moderate Points**	**Dense Points**	**Overall**
2016	58 (13.00%)	56 (12.60%)	46 (10.60%)	30 (6.73%)	190 (42.60%)
2017	39 (8.74%)	21 (4.71%)	8 (1.80%)	0 (0.00%)	68 (15.25%)
2018	23 (5.16%)	6 (1.40%)	0 (0.00%)	0 (0.00%)	29 (6.56%)
2019	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
2020	4 (1.36%)	1 (0.34%)	0 (0.00%)	0 (0.00%)	5 (1.7%)
2021	2 (0.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (0.45%)

Hudson River SAV Surveys

Between August 24 and September 4, biologists from SŌLitude and DEC's ISCS staff surveyed 29 high-priority sites along the Hudson River. Sites were deemed high-priority based on the following habitat characteristics that are suitable for hydrilla:

- Bathymetry,
- Suitable SAV habitat,
- Prior SAV abundance, and
- Proximity to the Croton River system.

Site information is organized by river mile in Table 3.

SŌLitude took a total of 1,469 GPS-referenced points at 29 high-priority sites and surveyed each point for SAV utilizing two 10-meter weed-rake tosses. The same point-intercept method used for SAV surveys was used for the Croton River sites. Samples from each rake toss were identified to species when possible and percent cover was estimated. SŌLitude observed no hydrilla plants at any of the Hudson River high-priority sites during the 2021 survey.

Table 3: 2021 Hudson River High-Priority Sites for Hydrilla Monitoring			
Site Name	River Mile	Size (Acres)	Points
Devries Park	25	9.0	45
Kemeys Cove	31	12	30
Croton Bay	34	639	78
Croton Landing Park	34	5.5	40
Half Moon Bay	35	76.7	66
Cedar Pond Brook	37	29.0	58
Oscawana Park	37	19.0	45
George's Island Park	39	31	60
Lents Cove	43	39	57
Dickey Brook	43	5.7	20
Annsville Creek	44	144.5	83
Iona Marsh	45	152	69
Popolopen Creek	46	13	35
Manitou Marsh South	46	47.0	31
Manitou Marsh North	47	16.0	25
Constitution Marsh	52	358	96
Foundry Cove Bay	53	6.7	28
Foundry Cove	53	41.5	64
Mayor's Park	54	8.0	34
Moodna Creek Bay	57	49	68
Fishkill Creek	59	41.7	48
Balmville Marsh	64	13.0	30
Wappingers Creek	67	94.3	50
Poughkeepsie Yacht Club	83	39	40
Black Creek Preserve	83	36	48
Mills-Norrie State Park	84	28	50
Vanderburgh Cove	87	98.6	42
Sleightsburg Park	90	224.0	100
Kingston Point Marsh	91	31	29

Hydrilla Tuber Monitoring

DEC's contractor has conducted tuber surveys on the Croton River since 2016. On November 2 and 9, SŌLitude conducted hydrilla tuber monitoring for the 2021 treatment season. Tuber survey sites in the Croton River included Black Rock Park (BRP-3, BRP-4), Silver Lake Beach (SLB-1), and north and south of Paradise Island (CR-1, CR-2, CR--3, CR-4, and CR-5). Survey site maps can be found in Appendix B. Biologists from SŌLitude collected tubers using a modified post-hole digger. Tuber density was calculated and expressed in tubers/m2 (meters squared).

Table 4 contains a summary of tuber survey data for the entire project thus far. No tubers or turions were found at any of the tuber survey sites in 2019, 2020, or 2021. The steady decrease in tuber density since the control project began is evidence that fluridone treatment has significantly reduced the fitness of hydrilla and that treated plants were not able to form tubers during the 2021 growing season at the sites sampled.

As hydrilla abundance has been reduced via treatment, monitoring efforts have increased. The number of cores collected per site has increased: in 2017, 3–6 cores per site; in 2018, 15 cores per site; in 2019, 20–30 cores per site; in 2020, 25–35 cores per site; and in 2021 30-35 cores per site.

Hydrilla tubers can persist in the sediment and remain viable for a minimum of six years (Nawrocki, 2016). Exhausting the tuber bank in order to prevent reinfestation is a critical part of this treatment project.

Table 4: 2016–2021 Croton River Hydrilla Monitoring Results										
Sample Location	Site	2016			2017			2018		
		# of Cores	Tubers (m^2)	Turions (m^2)	# of Cores	Tubers (m^2)	Turions (m^2)	# of Cores	Tubers (m^2)	Turions (m^2)
Black Rock Park	BRP-3	3	1,637.6	35.6	6	35.6	8.9	NA	–	–
	BRP-4	3	498.4	0.0	3	516.2	160.2	NA	–	–
Silver Lake Beach	SLB-1	3	2,082.6	53.4	3	231.4	35.6	NA	–	–
Croton River	CR-1	3	872.2	231.4	3	0.0	0.0	15	0.0	0.0
	CR-2	4	495.8	321.6	5	96.3	21.4	15	0.0	0.0
	CR-3	4	174.2	67.0	3	106.8	89.0	15	0.0	0.0
	CR-4	5	0.0	32.1	3	35.6	0.0	15	39.2	3.6
	CR-5*	–	–	–	–	–	–	–	–	–
Sample Location	Site	2019			2020			2021		
		# of Cores	Tubers (m^2)	Turions (m^2)	# of Cores	Tubers (m^2)	Turions (m^2)	# of Cores	Tubers (m^2)	Turions (m^2)
Black Rock Park	BRP-3	20	0.0	0.0	25	0.0	0.0	30	0.0	0.0
	BRP-4	20	0.0	0.0	25	0.0	0.0	30	0.0	0.0
Silver Lake Beach	SLB-1	30	0.0	0.0	35	0.0	0.0	35	0.0	0.0
Croton River	CR-1	NA	–	–	25	0.0	0.0	30	0.0	0.0
	CR-2	20	0.0	0.0	25	0.0	0.0	30	0.0	0.0
	CR-3	NA	–	–	25	0.0	0.0	30	0.0	0.0
	CR-4	20	0.0	0.0	25	0.0	0.0	30	0.0	0.0
	CR-5*	–	–	–	25	0.0	0.0	30	0.0	0.0

Outreach

Outreach plays a significant role in the project by addressing concerns about recreation, drinking water, and the spread of invasive species. On May 4, 2021, DEC hosted a pre-season virtual public meeting that detailed plans for 2021 treatment season operations. A post-treatment season virtual public meeting held on Nov 4, 2021 reviewed data, analyzed trends from the past five years, and discussed a proposed 6th year of treatment in 2022. An informational brochure was mailed with the Article 15 notification letters to all river-adjacent property owners prior to 2021 treatment. DEC sent status updates to key partners regularly via an email listserv and held conference calls regularly with partners in other infested regions of New York State. Project staff also participated during monthly New York State Hydrilla Task Force calls led by DEC's Bureau of Invasive Species and Ecosystem Health to share information with other New York regions and neighboring states combating hydrilla.

Hydrilla Fact Sheet and ID

DEC and its partners use DEC's hydrilla fact sheet, ID sheet, and ID card to educate the public about hydrilla in New York. These outreach materials help people learn how to identify hydrilla, tell it apart from look-alikes, and report potential locations to DEC so we can help control it. Links to these outreach documents are available on the hydrilla page of DEC's website: **www.dec.ny.gov/animals/104790.html** Paper copies can be requested by contacting DEC's Invasive Species Coordination Section at isinfo@dec.ny.gov.

Webpage

DEC's hydrilla webpage (**www.dec.ny.gov/animals/104790.html**) provides information on this prohibited invasive plant. The webpage was visited 3,464 times in 2021 (a 23% increase from 2020). A separate webpage discusses the Croton River Hydrilla Treatment Project (**www.dec.ny.gov/animals/106386.html**) and was visited 415 times in 2021 (a 12% increase from 2020). SŌLitude and the Village of Croton-on-Hudson Water Department monitored drinking water throughout the project for fluridone concentration and DEC made the results available to the public on its Water Sample Analysis webpage (www.dec.ny.gov/animals/110624.html), which was visited 90 times in 2021 (a 1% increase from 2020). While these webpages are frequently accessed by people from New York State and around the world, a decrease in project-specific page views can be expected as many stakeholders/residents have become more familiar with the project by year four.

Watercraft Inspections

LH PRISM participated in the Watercraft Inspection Steward Program (WISP) in 2018, 2019, 2020, and 2021. WISP is a statewide effort to prevent the spread of aquatic invasive species. Trained staff inspected recreational boats and equipment as boaters launched and removed watercraft from the Croton River at Echo Boat Launch. They collected data during each inspection and uploaded them using the Watercraft Inspection Steward Program App (WISPA). The New York Natural Heritage Program manages a statewide database from WISPA, which contains all watercraft inspection data provided by various PRISMs and local private and public entities. The watercraft inspection stewards at Echo Boat Launch conducted 662 recreational boat inspections in 2018, 584 in 2019, 1,233 in 2020, and 1,104 in 2021. They observed no hydrilla plant fragments on boats or equipment during those inspections. Stewards also disseminated information on how to properly clean, drain, and dry watercraft to prevent the spread of invasive species during inspections. For more information on WISPA, please visit https://**www.nyimapinvasives.org/wispa**.

Partnerships

In 2021, the Croton River Hydrilla Control Project continued to rely on strong working relationships and collaborative efforts with a variety of organizations and groups. While DEC serves as the lead agency for this project, the Village of Croton-on-Hudson Water Department and the New York City Department of Environmental Protection (NYCDEP) were vital to the success of the project.

Program staff have provided partner agencies with an initial training on hydrilla identification, infestation case studies, potential control methods, and an overview of Croton River Hydrilla Control Project protocols and data collection.

In 2021, the following partners conducted various snorkel and SCUBA surveys with the Croton River Hydrilla Control Project:

- Lower Hudson PRISM (LH PRISM) Aquatic Invasives Strike Force
- Kathleen Bezik – project volunteer
- SePRO Corporation

The following partner agencies and DEC units assisted with program operation:

- Village of Croton-on-Hudson Water Department
- New York City Department of Environmental Protection (NYCDEP)
- DEC Region 3 Fisheries Unit
- DEC Region 3 & Region 4 Departments of Materials Management

New Croton Reservoir Hydrilla Infestation

In 2021, NYCDEP began a full-scale hydrilla treatment project within New Croton Reservoir (following small-scale pilot projects in 2018, 2019, and 2020).

Hydrilla fragments are transported to both the Croton and Hudson Rivers downstream during reservoir spill events. A full-scale fluridone treatment within the reservoir significantly decreases the potential of reinfestation in the Croton River and establishment in the Hudson River Estuary. Hydrilla successfully treated with fluridone is unlikely to produce tubers or reestablish from fragments. New Croton Reservoir treatment is therefore vital to the success of the Croton River treatment.

NYCDEP's hydrilla treatment utilizes the same herbicide (fluridone) at the same target concentration and uses the same contractor (SŌLitude Lake Management) as the Croton River treatment project. The project is slated for three years, with a potential for extension. DEC continues to work in close coordination with NYCDEP on our respective projects. In 2021, Article 15 Pesticide Permits were coordinated among the projects in order to ensure smooth communication and reporting.

In 2021, NYCDEP contractors also completed presence/absence surveys for hydrilla within Boyds Corner, Kensico, Muscoot, and West Branch Reservoirs, and no hydrilla was found to be present there. Additional NYCDEP East-of-Hudson reservoirs are scheduled to be surveyed for hydrilla in 2022 and beyond.

Figure 9: Treated hydrilla fragments from the New Croton Reservoir 1 week after treatment began in 2021.

Conclusion

Fluridone treatment continues to decrease the abundance and fitness of hydrilla plants in the Croton River. The few plants that were found throughout all 2021 surveys showed significant signs of herbicide injury. No tubers or turions were observed during any 2021 survey. As hydrilla biomass decreases, rooted plants, fragments, and tubers will become more difficult to find. The Croton River is a high-flowing system and environmental conditions can change rapidly throughout the year. Monitoring efforts in 2021 were impacted due to increased discharge and turbidity from New Croton Reservoir, as well as impacts from Hurricane Ida. The 70-day treatment achieved in 2021, also fell short of the 90-day project goal.

Looking Forward

While 2021 marked the 5th year of successful hydrilla treatment in the Croton River, a 6th year of fluridone treatment (2022) is proposed in order to ensure that any remaining hydrilla plants within the Croton River will be treated.

Additional survey efforts are also proposed for 2022 in an effort to locate any remaining plant biomass. DEC will continue to rely on adaptive management strategies and close cooperation with our partners managing the New Croton Reservoir infestation in order to reduce the threats that hydrilla poses to the Hudson River watershed. All necessary project permits will be renewed prior to treatment in 2022.

The *Croton River Hydrilla Control Project Five-Year Management Plan* continues to provide the framework for decision-making and adaptive management strategies. DEC and its partners will continue to build upon our experience with each year of treatment and communicate regularly with NYCDEP regarding the necessary treatment of the source of the hydrilla infestation in the New Croton Reservoir. The Croton River Hydrilla Control Project Team will plan for additional seasons of monitoring after the end of treatment in 2022.

Sources

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Madsen, J. D. (1999). "Point and Line Intercept Methods for Aquatic Plant Management." APCRP Technical Notes Collection (TN APCRP-M1-02), U.S. Army Engineer Research and Development Center, Vicksburg, MS, 1–16.

Nawrocki, J. L., R. Richardson, and S. T. Hoyle. 2016. "Monoecious Hydrilla Tuber Dynamics following Various Management Regimes on Four North Carolina Reservoirs." *Journal of Aquatic Plant Management*, 54, 12–19.

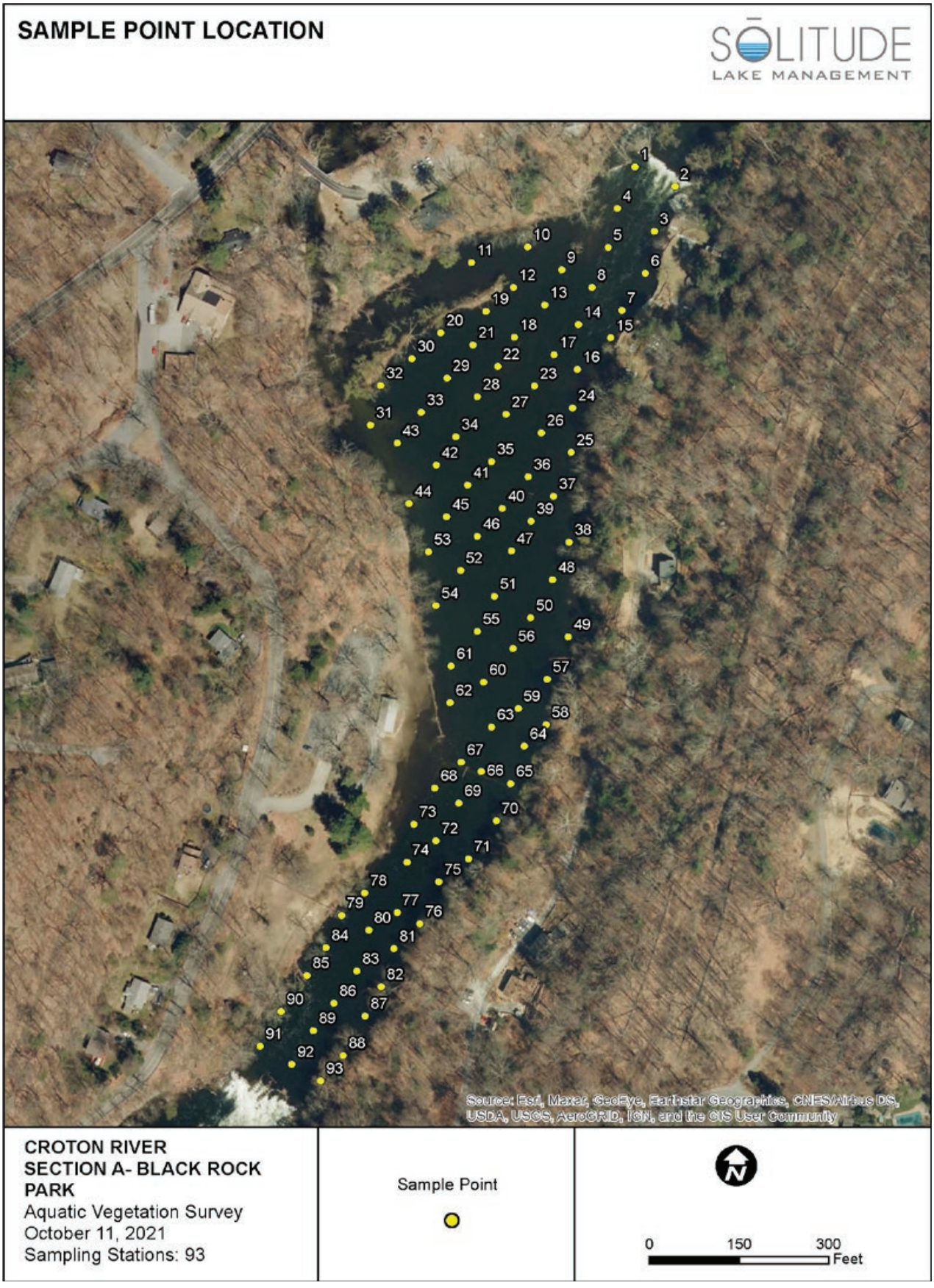
SŌLitude Lake Management. 2021. "Croton River 2021 Treatment Final Report." Unpublished data.

SŌLitude Lake Management. 2021. "2021 Delineation of Hydrilla and Other Submerged Aquatic Vegetation (SAV) in the Croton River." Unpublished data

Appendix A: Helpful Links

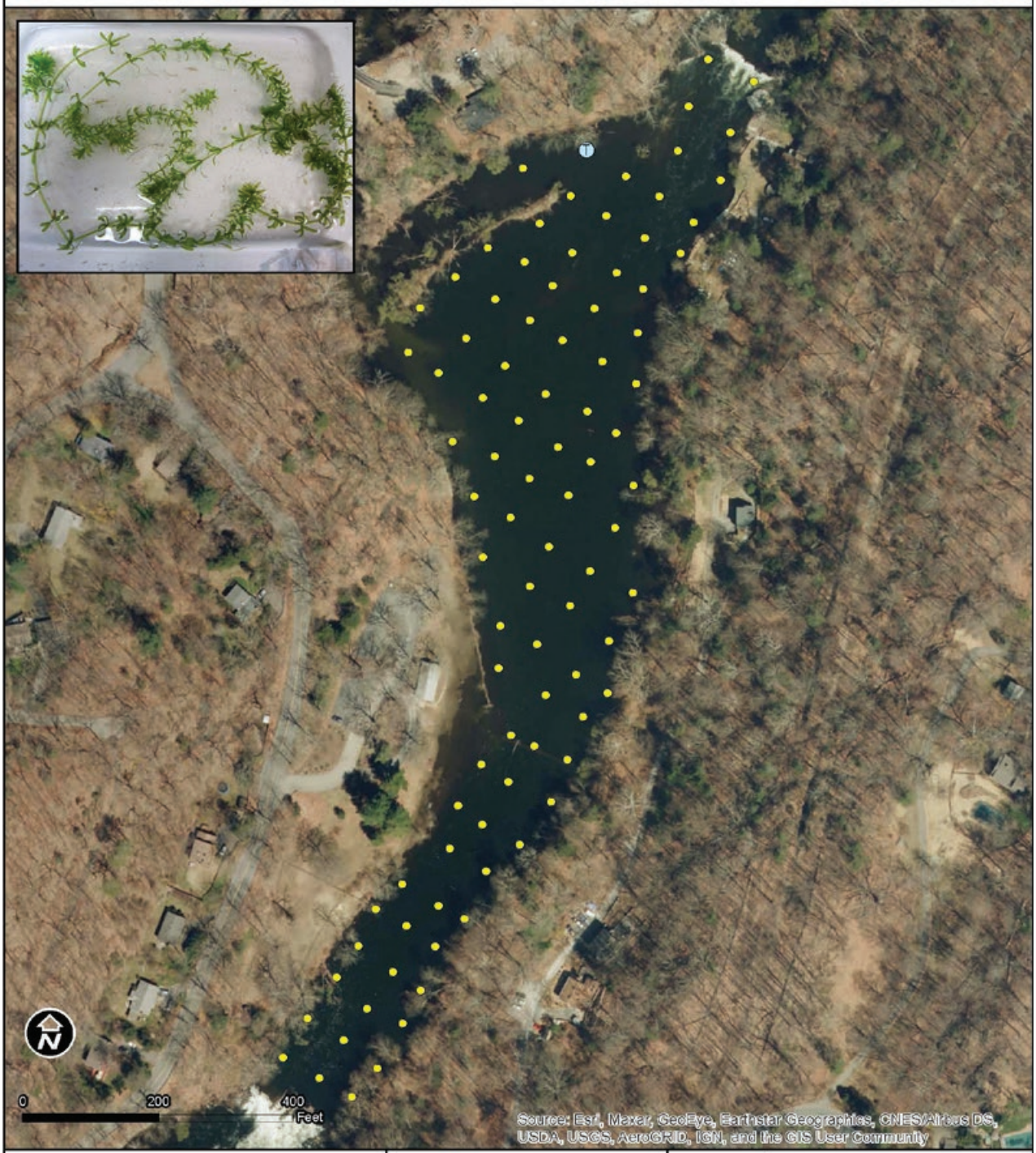
- DEC Hydrilla Webpage
  https://www.dec.ny.gov/animals/104790.html
- DEC Croton River Hydrilla Control Project Webpage and Five-Year Management Plan
  https://www.dec.ny.g-ov/animals/106386.html
- DEC Croton River Hydrilla Control Project's Water Sample Analysis Results Webpage
  https://www.dec.ny.gov/animals/110624.html
- Sonar® Genesis NYS Label
  https://www.dec.ny.gov/docs/lands_forests_pdf/sonarlabel2017.pdf

Appendix B: Survey Site Maps



HYDRILLA (*Hydrilla verticullata*) DISTRIBUTION

SŌLITUDE LAKE MANAGEMENT



CROTON RIVER
SECTION A- BLACK ROCK PARK
Aquatic Vegetation Survey
October 11, 2021

Sampling Stations: 93

Plant Density

- No Plants
- Trace Plants
- Sparse Plants
- Medium Plants
- Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	1	1%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

SAMPLE POINT LOCATION

SOLITUDE LAKE MANAGEMENT

CROTON RIVER
SECTION B- SILVER LAKE BEACH
Aquatic Vegetation Survey
October 12, 2021

Sampling Stations: 30

Sample Point

N

0 130 260 Feet

HYDRILLA (*Hydrilla verticillata*) DISTRIBUTION

SOLITUDE LAKE MANAGEMENT

CROTON RIVER
SECTION B- SILVER LAKE BEACH
Aquatic Vegetation Survey
October 12, 2021

Sampling Stations: 30

Plant Density

- No Plants
- Trace Plants
- Sparse Plants
- Medium Plants
- Dense Plants

Percent Distribution

Abundance	Sites	Percent
Total	1	3%
Trace	1	100%
Sparse	0	0%
Medium	0	0%
Dense	0	0%

SAMPLE POINT LOCATION

SOLITUDE LAKE MANAGEMENT

CROTON RIVER
SECTION C-ISLANDS
Aquatic Vegetation Survey
October 5, 2021

Sampling Stations: 70

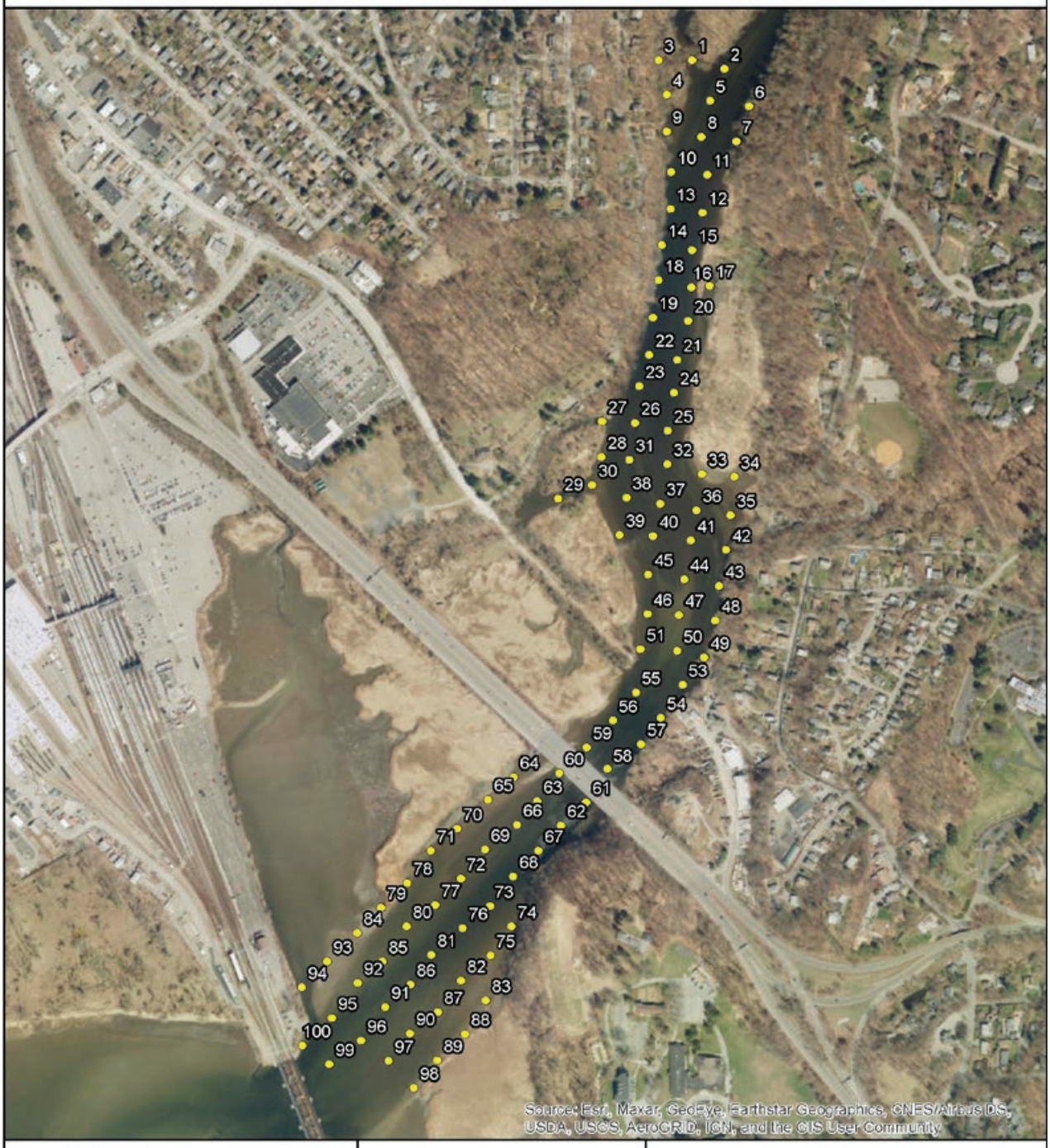
Sample Point

N

0 250 500 Feet

SAMPLE POINT LOCATION

SOLITUDE LAKE MANAGEMENT



CROTON RIVER
SECTION D- LOWER RIVER
Aquatic Vegetation Survey
October 4, 2021
Sampling Stations: 100

SAMPLE POINT LOCATION

SOLITUDE LAKE MANAGEMENT

CROTON RIVER
SECTION E- LOWER COVES
Aquatic Vegetation Survey
October 6, 2021

Sampling Stations: 105

Sample Point

N

0 460 920 Feet

SAMPLE POINT LOCATION

SOLITUDE LAKE MANAGEMENT

CROTON RIVER
SECTION F- CROTON BAY WETLANDS
Aquatic Vegetation Survey
October 12, 2021

Sampling Stations: 48

Sample Point

N

0 320 640 Feet

BLACK ROCK PARK
Hydrilla Tuber Sampling Locations

SOLITUDE LAKE MANAGEMENT

Croton River
Black Rock Park

Hydrilla Tuber Sampling 2021

Site	Latitude (NAD83)	Longitude (NAD83)
BR-3	41.214637°	-73.866032°
BR-4	41.214519°	-73.865724°

N

0 20 40 80 Meters


SILVER LAKE BEACH & RIVER ISLANDS
Hydrilla Tuber Sampling Locations
SOLITUDE
LAKE MANAGEMENT
SLB-1
CR-1
CR-2
CR-3
CR-4
CR-5
Croton River
Silver Lake Beach & River Islands
Hydrilla Tuber Sampling 2021
Site | Latitude (NAD83) | Longitude (NAD83)
SLB-1 | 41.20684° | -73.87124°
CR-1 | 41.20316° | -73.87268°
CR-2 | 41.19987° | -73.87261°
CR-3 | 41.19907° | -73.87253°
CR-4 | 41.19599° | -73.87332°
CR-5 | 41.19550° | -73.87344°
N
0 62.5 125 250
Meters


NEW
YORK
STATE
Department of
Environmental
Conservation